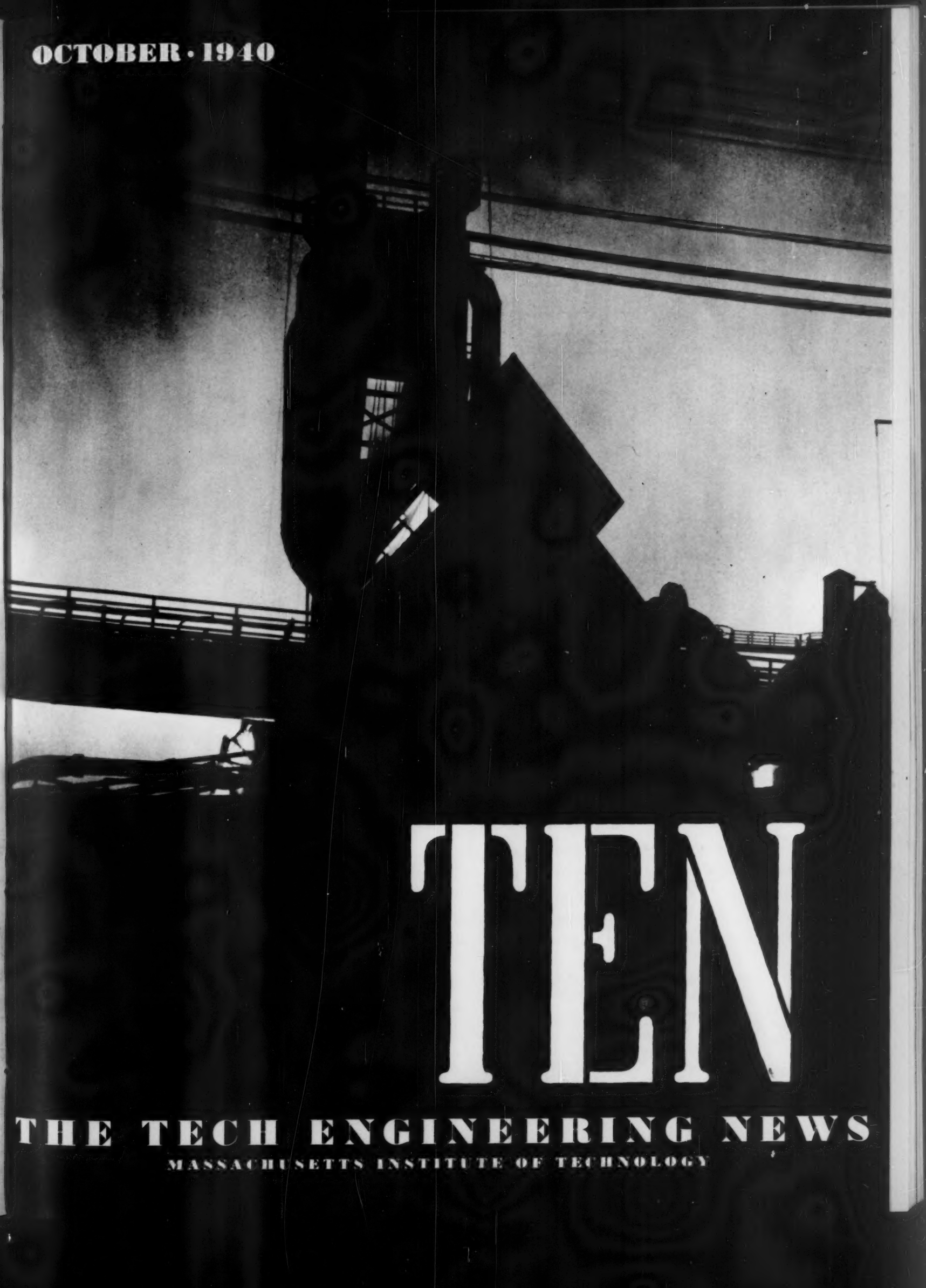
OCTOBER · 1940



TEN

THE TECH ENGINEERING NEWS

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

REQUIREMENTS MET AND MONEY SAVED

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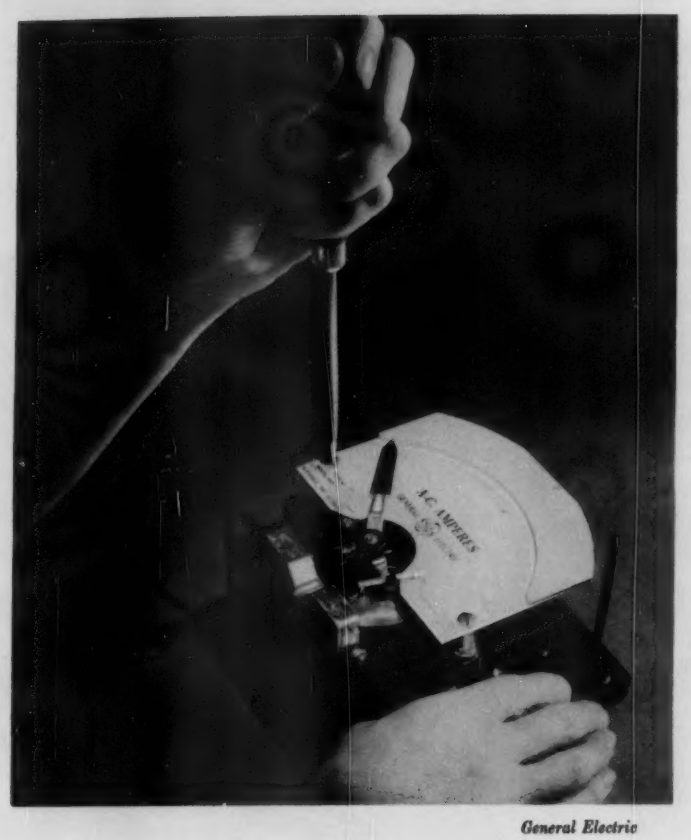

General Electric

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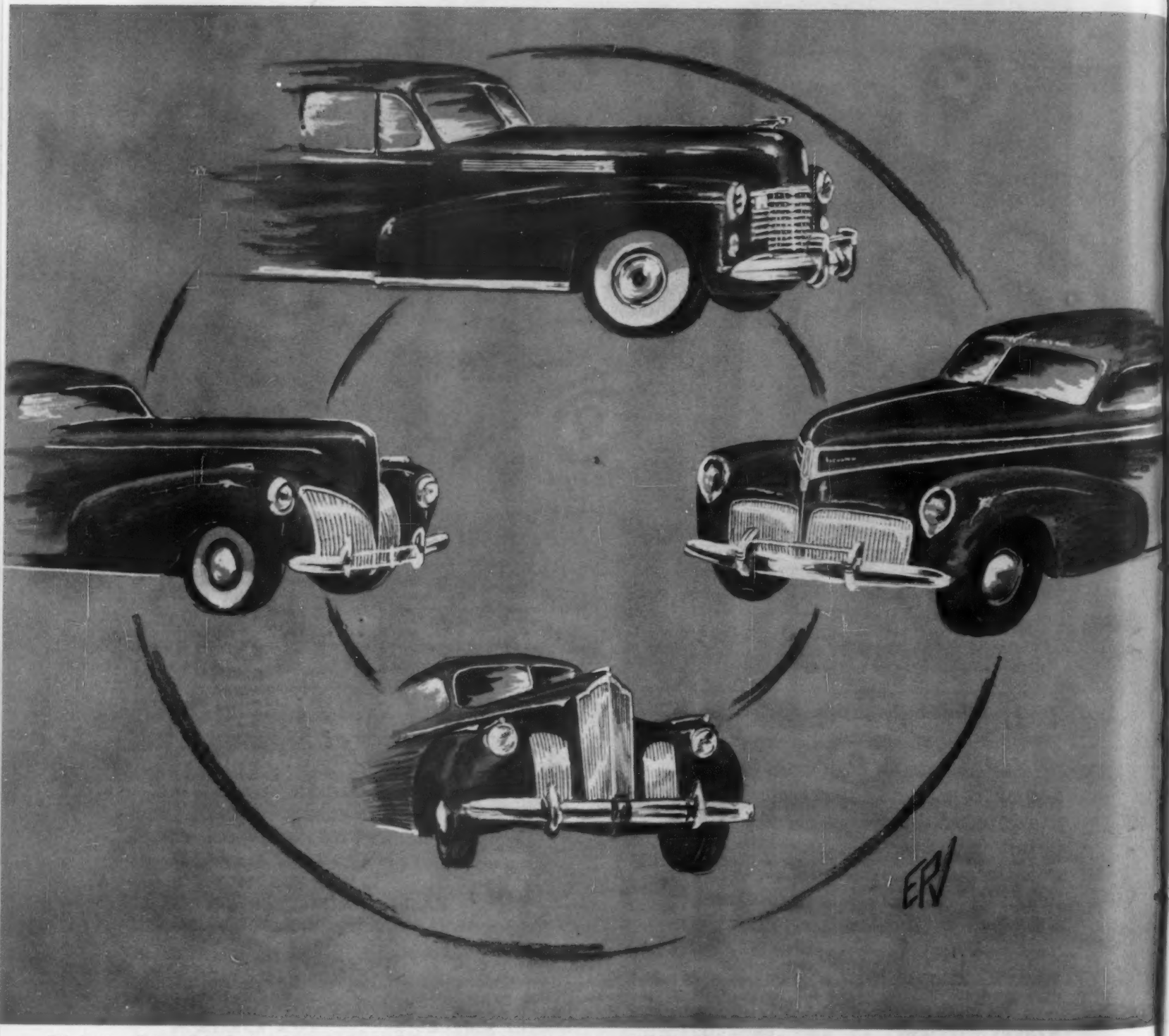


Edwin Van Sciver, '42, depicts for us several of the automotive newcomers of 1941. *(See page 259)*

May Fair

A CHALLENGE

DEMOCRACY NEEDS ENGINEERS WHO CAN WORK WITH PEOPLE AS WELL AS WITH THINGS

By ADAM K. STRICKER, Jr.

CHAIRMAN'S STAFF, GENERAL MOTORS CORPORATION, NEW YORK CITY
AND FORMERLY EDITOR-IN-CHIEF OF THE TECH ENGINEERING NEWS

IT is a great privilege to me as a former editor of THE TECH ENGINEERING NEWS to have the opportunity of addressing the Class of 1944 through its pages.

As I look back upon the world scene of 1925 when I entered the Institute and compare it with today's scene, I am impressed with the challenge that confronts you as America's future leaders. You, who are to receive the finest scientific education that may be obtained anywhere in the world today, have an obligation to society to solve the problems responsible for the breakdown of our enterprise system, and of the Democratic way of life in so many parts of the world.

In its regular courses of study the Institute will provide you with a scientific training, coupled with the engineer's approach that will give you the opportunity in the years to come to make a contribution to society if you can assert your leadership among your fellowmen who have not had the intellectual capacity and ability to carry through an educational program such as the one you are about to commence. In order for you to establish such leadership it will be necessary for you to work with others towards a common objective. It is necessary for you to learn how to convince others of the soundness of your views and position on matters of vital interest to you and to the community as a whole.

There is no better way of preparing yourselves to meet this aspect of life after graduation than by active participation on the staff of THE TECH ENGINEERING NEWS. Looking back over my days at the Institute I realize that I can never begin to repay my debt to Technology for the training and instruction I received, and I am particularly indebted to THE TECH ENGINEERING NEWS for my activity experience which supplemented my technical training and played a vital part in my development in the years following graduation.

Your education is made possible by the Institute's endowment. In turn, this endowment is dependent upon the preservation of our enterprise system. The generations which preceded you established in this country a Republican form of Democratic government and an economic system operated through free private enterprise. This foundation has enabled us to make rapid progress in advancing the standard of living of our people and if science and industry are given a reasonable opportunity, there is no doubt in my mind that the progress we have made can be further advanced so that in time poverty will be eliminated throughout the world.

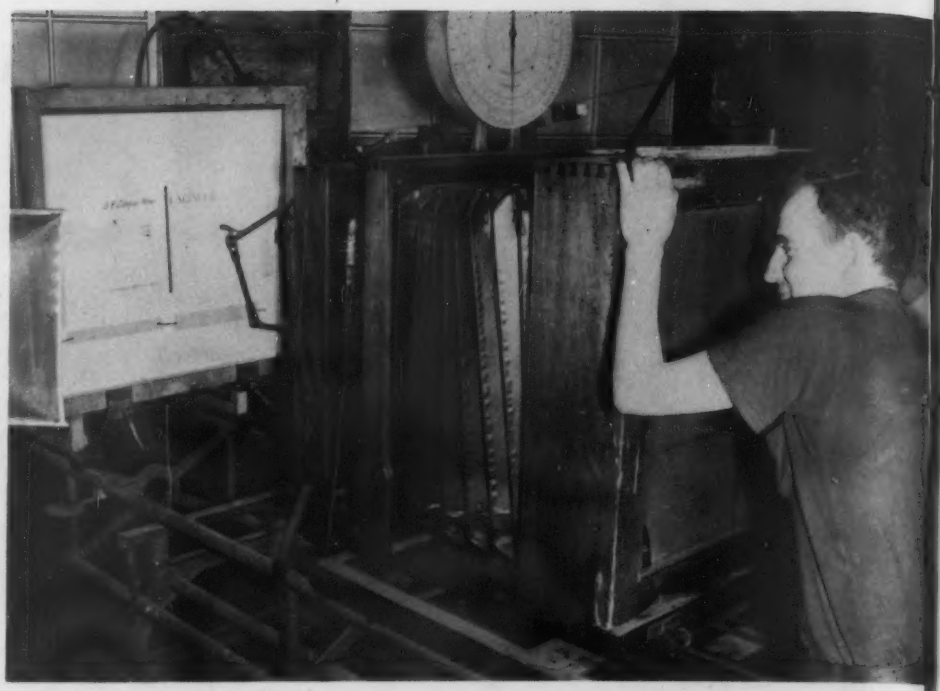
Science which offers such promise to the human race has been perverted by men who completely lack the scientific spirit and who have achieved political power by demagoguery. The radio has been an important factor in increasing the power of the demagogue — both here and abroad. The airplane which enables us to shrink the entire globe so that no point is more than a few days away from any other is being used today to destroy the accumulated culture of centuries.

None of us can predict what the immediate future will bring, and our country may require your maximum efforts for defense before this crisis has passed. At the moment, the most vital task before us is to aid in getting our country thoroughly and promptly armed so that we may be well prepared to defend our institutions. In due time, you of the Class of 1944 will have an opportunity to play a part in determining the policy for our future course as a nation. You have a responsibility to the Institute, to your families and to yourselves to exert every effort to bring the scientific spirit to bear

upon your contemporaries so that the problems we face in an industrial age may be approached objectively without rancor or prejudice. You must see to it that industry and science together may go forward again to expend our productive powers, and it will be your task to conquer the fears, the ignorance, and the emotional reactions of the uninformed to the soundness of the measure which you, as the future industrial leaders of the nation, must attempt to bring to pass. Your training at the Institute will prepare you to achieve leadership in our industrial life, but under our system of government you must secure the consent of those whom you are leading. Any other system of leadership would be abhorrent to the American way. In the past, engineers have failed in securing the adherence of the great mass of our people towards sound economic doctrine, particularly as regards the problems of modern technological progress and technological unemployment. During the past year a Bill was introduced in the Senate of the United States to place a tax upon technological progress. While the Senate of the United States was considering this proposal, Germany was resorting to every scientific procedure to increase the productivity of her economy. Science, industry, and our way of life will fail unless those who understand the industrial processes and how they contribute to the "more abundant life" are able to transmit their understanding to the rest of the community.

One of the problems which will confront you after graduation will be to reduce a governmental debt of prodigious proportions. Many in high places today have never had to operate within a budget and do not understand the necessities imposed by sound business management. THE TECH ENGINEERING NEWS is a business institution and it has been operated as such for many years. Those of you who elect to serve in the advertising and business management departments will have an opportunity to actually manage a business enterprise while at the Institute. All Technology activities provide this type of mental training and at Technology it can truly be said that undergraduate activities are managed in all their phases by the undergraduates without faculty direction.

It is my considered judgment that participation in the management of THE TECH ENGINEERING NEWS during the next four years offers you a rare opportunity to develop the art of working with others, of transmitting your views to others, and of actually assuming the financial and managerial obligations of a business enterprise. Naturally, I speak from my own experience, but I have no hesitancy in stating that THE TECH ENGINEERING NEWS has played a vital part in my development and in what little I have accomplished since graduation. I am sure that with the challenge before you at this time it can play an even more important part in your development.



Experience in Photography, Printing, and Composition is also afforded the T. E. N. staff member.

DETROIT'S CLASS OF '41

By HARVEY FREEMAN, '43

AN emphasis on power, acceleration, and road stability, combined with improvements in style, comfort, and driving ease, keynote the efforts made by the manufacturers in meeting the consumer's car demand for 1941. The following paragraphs will present to the engineer the new trends making for very evident advancement in the automobile.

PLYMOUTH

"Powermatic" gear-shifting, a new "high-torque" engine, and numerous other mechanical advancements feature Plymouth's bid for sales superiority in 1941. Horsepower has been stepped up to 87, with a corresponding torque increase over the entire speed range.

A notable Plymouth feature is the new "get-away gear," with which it is possible to start in second to provide a correspondingly higher acceleration. It is made possible by means of new transmission and rear axle gear ratios, combined with added engine power.

The new Powermatic gear-shift employs a vacuum from the engine to do 80 per cent of the work of changing to any gear.

A novel improvement in the interests of safety is Plymouth's new safety-rim wheel design, aimed at preventing "throwing" a flat tire off the wheel even at high speeds. With this new rim, a completely flat tire gives the same performance as a tire inflated to a pressure of ten pounds on the standard type wheel.

The more important among the company's engineering claims include this year's "high-lift" camshaft design, constructed to enable a larger volume of fuel to enter the compression chamber per piston stroke.

In order to facilitate a smoother, steadier, and more economical fuel flow, a new wide-radius intake manifold has been adopted.

DODGE

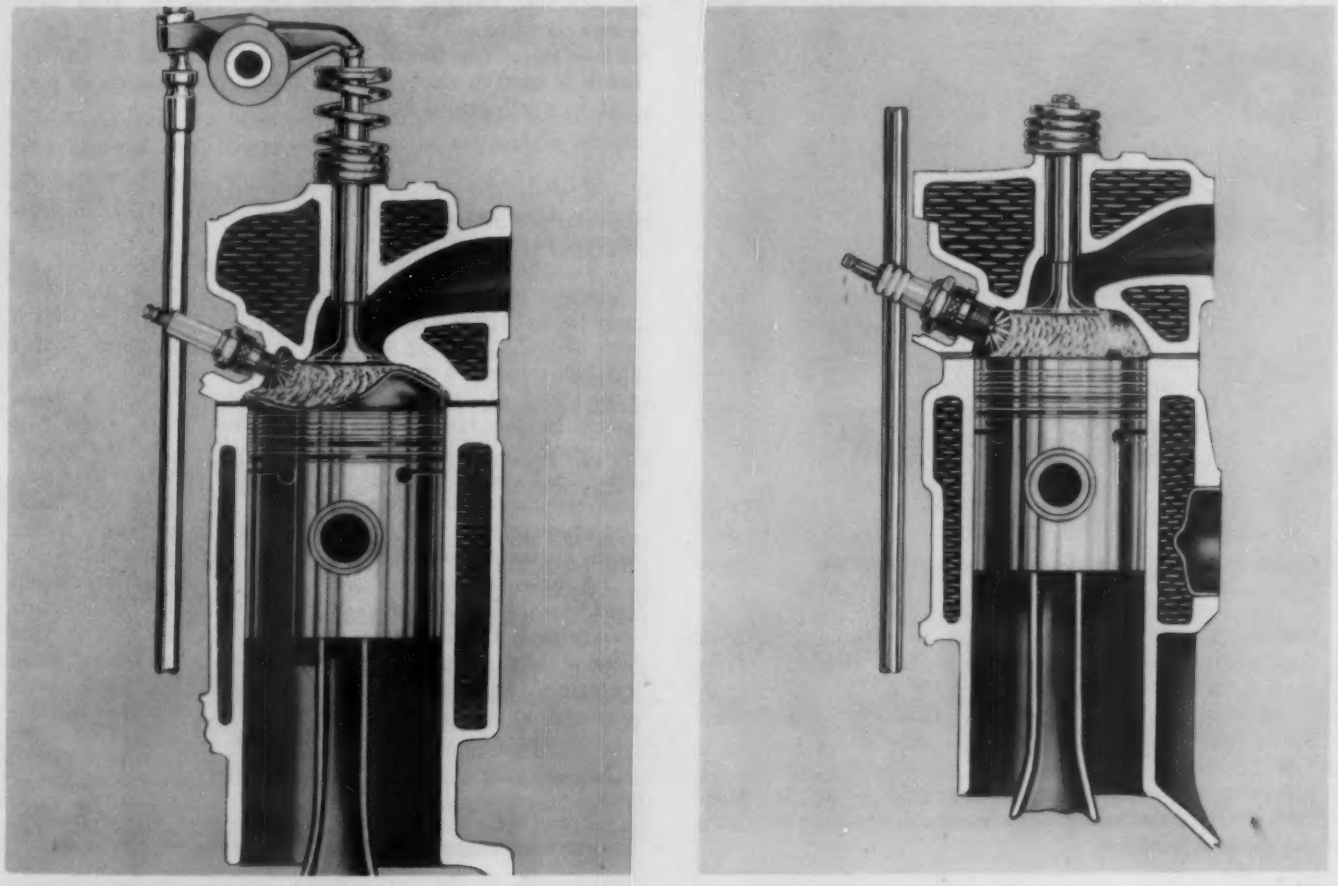
Being the first car in the lower price brackets to boast a liquid coupling between motor and wheel, Dodge offers Fluid Drive as its major advancement for 1941.

Body contours and dimensions, interiors, and upholstering have been changed for 1941. Even the figure of the Rocky Mountain sheep, which adorned the Dodge radiator for many years as ornament and identification mark, has been replaced by a newer ornament streamlined to harmonize with body contours.

The Dodge frame, formerly featuring the X-type of construction, is of a different closed-in box-section type permitting further lowering of the floor and providing, it is claimed, greater rigidity.

Other mechanical improvements include: increased

Diagrammatic comparison of dome-shaped and conventional piston



horsepower; adoption of the heavy-duty type of oil-bath air-cleaner as standard equipment; twofold fuel filtering; a new gear-shifting mechanism mounted at the side of the transmission which shortens the shifting movement to four inches; higher second speed transmission ratio, increased from 1.55 to 1.83 to give faster acceleration when starts are made from second speed.

The rear spring leaves are of grooved cross section to reduce spring stresses. At the back end of the rear springs, special rubber-insulated shackles are used to isolate the axle from the frame and consequently reduce road sounds and vibration.

The Pitman arm of the steering system is rubber insulated for more shock-free steering.

LINCOLN-ZEPHYR

Improvements in road stability and riding ease are the standout features of the Zephyr for 1941.

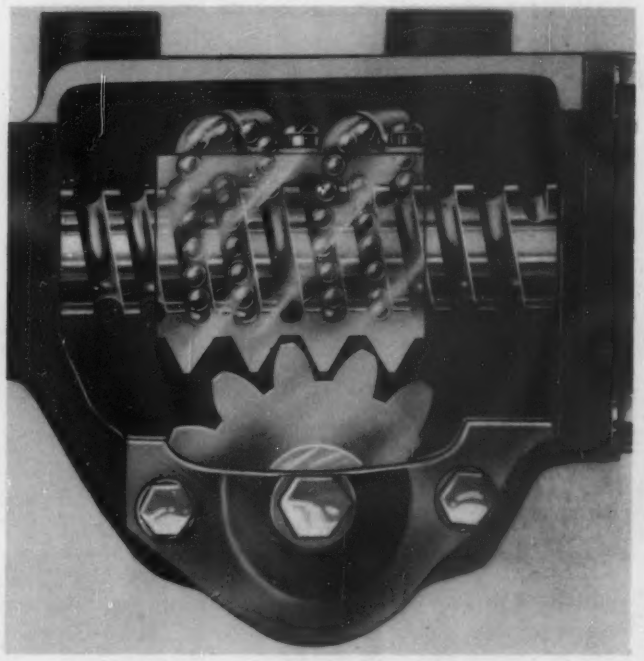
The Lincoln Continental, introduced last year in the cabriolet body, is now effected both as a cabriolet and six-passenger coupe of equal distinction.

All Lincoln models are powered with the Lincoln V-12 engine. A compression ratio of 7.02 to 1, together with improvements in manifolding and distributor design, now permit the motor to deliver 120 horsepower at 3,600 R.P.M.

All door interiors are provided with flush-type push-button latches, which in the Lincoln Continentals are employed on the door exteriors as well, thus dispensing entirely with door handles.

The Lincoln Custom features a hydraulic system which raises and lowers door windows at a touch of a button. Dual control is provided, with buttons also on the instrument panel for windows not readily within the driver's reach.

On the limousine, the same system also raises and lowers the partition between the front seat and rear. The Lincoln Custom cars offer the added convenience feature of a hydraulic adjustment for the front seat. Pressure on a button moves the seat automatically into the desired position.



Cutaway view of new steering gear mechanism *Buick*

PONTIAC

Three lines of cars, all patterned along basic Torpedo styling, are offered by Pontiac for 1941.

Although radiators, hoods, and fenders have been restyled to further the Torpedo design, Pontiac retains its Silver Streak as a basic style theme for the seventh consecutive year.

A new method of mounting the 1941 bodies makes it possible for Pontiac to further lower the front and rear door sills without sacrificing road clearance. Utilizing this advantage, Pontiac engineers have added a new feature to the De Luxe and Streamlined Torpedo models in the individual door steps completely enclosed and concealed by a flare in the lower edge of the door.

For 1941, piston pins have been redesigned with the slot at the side rather than at the bottom. Tests show this type of construction to withstand 30 per cent more punishment before breaking. Aluminum-bronze piston pin bushings, which are less affected by the acidic tendency of some oils, are also a new addition.

DE SOTO

Heading a long list of improvements, Simplematic Transmission and Fluid Drive will be offered on all De Soto models for 1941.

With 121½ inch wheelbase and 105 horsepower high-compression L-head engine, De Soto's overall length has been increased 5½ inches, to 207¾ inches, and over-all height reduced 1½ inches without a sacrifice in headroom.

Added this year is a new stabilizer bar which is attached between the frame and rear axle. Its principal function is to lessen the side motion in the car, particularly on rough roads. There is also a front-end sway bar which tends to keep the body level when rounding curves.

Available as extras are front and rear directional signals operated from a control by the driver.

De Soto's engine has been improved this year with a new type of main bearing which has reportedly three to five times the life of the type formerly used. Super-finish is used in thirteen places where reduction of friction to a minimum is desired.

OLDSMOBILE

With Hydra-matic drive heading its list of improvements, Oldsmobile presents for 1941 the widest variety of cars in its forty-three year history.

All the mechanical improvements introduced by Oldsmobile in recent years are present in the 1941 models with refinements. The "Rhythmic Ride" with quadri-coil springing and four-way stabilization, is still further improved by the adoption of parallel cylinder-type shock absorbers at the rear. Gear shifting is made easier by the Handi-shift lever beneath the wheel and the clashless syncro-mesh gear designing in the transmission. Super-hydraulic brakes and a separate mechanical parking brake are provided. A drain has been incorporated in the cylinder head to prevent water from accumulating around the spark plugs.

A new heating and ventilating system, developed by Oldsmobile, is known as "Condition-air." Air taken in through the cowl ventilator passes through special filters that remove dust and prevent moisture from entering. In winter, the incoming filtered fresh air is warmed to any desired degree by varying the volume of hot water in coils through which it passes.

MERCURY

For 1941 the Mercury features new larger bodies, longer wheelbases, new interior treatment, and a newly

engineered ride. In addition, transmission gear ratios have been increased to provide faster acceleration.

The Mercury ride has been completely re-engineered. The long softer springs are slower in action, and operate with improved shock absorbers. In addition, the rear spring is longer, and a larger proportion of its length is made available for cushioning road shocks. A new ride stabilizer has been perfected which maintains balance on curves or in heavy cross winds.

An entirely new frame, claimed to be much more rigid than the conventional frame designs, supports the body which is cushioned on heavy rubber mountings With this frame, bodies are less subject to weaving.

FORD

Representing the most complete change in five years, Ford presents for 1941 a car alive with innovations and mechanical improvements.

The wheelbase of the new cars has been lengthened to 114 inches. Riding qualities have been greatly improved by means of longer, softer springs, improved shock absorbers and a newly designed stabilizer.

Bodies have been broadened to partially conceal the running boards, thus allowing as much as seven inches more seating room.

Both the new Ford lines for 1941 are built on the 114-inch wheelbase chassis and are powered with an 85 horsepower V-8 engine.

Improvement of the Ford ride starts with the frame. Greater strength and resistance to twisting was made possible by redesigning the X member and incorporating an all-welded box-type center section. Lower spring frequency, or "slower action," also are provided by new engineering so as to give passengers a soft, smoothly controlled ride.

Improved hydraulic shock absorbers on all four wheels allow the springs free play over moderate road surface, but provide firm control over rough roads and big bumps. They are the lever-arm type and are equipped with a simplified adjusting mechanism.

CHEVROLET

An increase in horsepower to 90, roomier bodies, and mechanical improvements feature Chevrolet's bid for continued sales leadership in 1941.

Numerous mechanical changes have been made in the new Chevrolet, many of them being in the interests of performance, riding quality, comfort, and long life; others being to adapt the chassis to 1941 style treatment. The increase in horsepower output has been due chiefly to changes in the shape of the combustion chamber and through raising the compression ratio.

One innovation is the provision of a reversing switch, which at each operation of the starter reverses the direction of the current through the ignition breaker points. This tends to equalize the deposition of metal from one breaker point to the other, and thus provides a longer life and higher unit efficiency.

Bore, stroke, and piston displacement are the same as in 1940, but the new 1941 piston, of cast alloy iron with slipper skirt, has a flat instead of a crowned top, and the cylinder head is revised to gain more effective combustion.

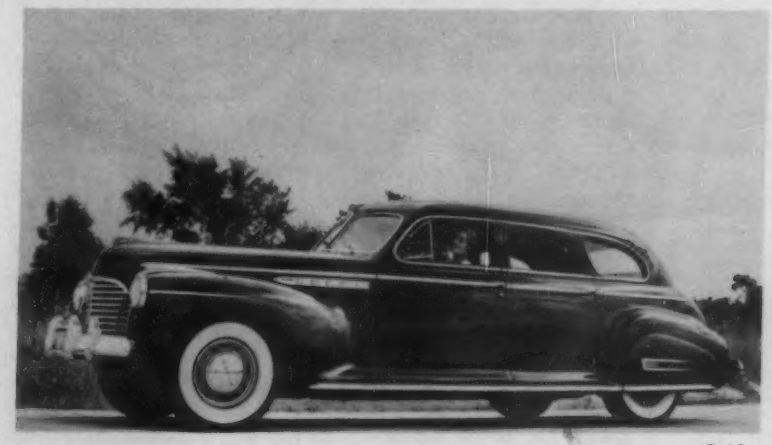
The specialized lubrication system, in which oil is delivered under pressure to the valve mechanism, crankshaft, and crankshaft bearings is retained for 1941 with refinements. The connecting rod bearings are oiled by pressure stream. Valve stem lubrication is improved to prevent excess oil from running down their stems and being vaporized by heat. The use of a new steel alloy

(*Continued on page 270*)

Nash

Mercury

Oldsmobile



Buick

To this scene of industry the sales engineer is vitally connected

DEMOCRACY NEEDS ENGINEERS WHO CAN WORK WITH MEN AS WELL AS THINGS

By F. J. CURTIS
MONSANTO CHEMICAL COMPANY

SELLING may be defined as the facilitation of the exchange of goods and services. The average chemical engineer, if asked his interest in the sales field, will usually come forth with a vigorous denial. He will say he has no interest in sales or he is not the right type, or he has some other reason to show that he feels that selling is something entirely foreign to his world. Yet all of us are selling every day. It does not do much good to develop a fine process if you cannot put it over, and putting over means selling. The whole field of sales is so broad and the problems so complex that I will confine myself to discussing the selling of chemicals, on the basis of the old adage that one should talk about something in his own experience.

In the selling of chemicals, for many years the non-technical salesmen were the rule, and it has been their efforts which have really built the chemical industry as far as selling is concerned, and to them must be paid a tribute for their great success. However, particularly since World War I, there has been a great growth of selling by technical men, of which many chemical companies are shining examples. Why should this have taken place? Much of it is due to the dynamic character of the new chemical industry. We have seen a constant acceleration in the rate of change. We have seen products hitherto laboratory curiosities industrialized so that they are sent around the country in tank cars and carloads. Who would have conceived twenty-five years ago that ethylene glycol, maleic anhydride, and trichlorethylene would be large scale industrial products?

In selling we may discern four steps: (1) know the product; (2) arouse interest; (3) present the case clearly, logically, and briefly; and (4) clinch the sale.

The chemical engineer is a man skilled in the large scale performance of chemical reactions, which skill has a vital relation to selling. If we take up the first stage, namely, knowing the product, it is obvious that the cook-book knowledge of the non-technical salesman must always be skin deep. This does not mean that we should despise it, but we should recognize that knowledge can go much further. It is just as important to know what a product will not do as what it will. The visualization of defects is as valuable as the realization of advantages. Nothing is weaker than a salesman who is forced to say that he will have to get his technical men to answer a question.

It is obvious that knowledge of the product will go a long way towards helping to arouse interest. Few problems are alike and the ability to discern how a

(*Continued on page 278*)

FLUID TRANSMISSION

HISTORICAL DEVELOPMENT AND OPERATION OF TURBOS

By JOHN A. SIBLEY

SINCE the invention of the internal combustion engine, engineers have sought a better method of connecting power to traction and a more flexible means of changing torque ratios. A solution to this important problem is offered by the introduction of the hydraulic drive now available on a number of makes of automobiles.

Although systems of achieving constant acceleration through some form of liquid coupling have long been considered, as shown by patents dating back as far as 1910, the units have not been made sufficiently light and compact for use in automobiles until recently. The heavier, more complicated installations have proven successful in trucks, buses, and rail-vehicles, particularly in Europe.

To understand the function of turbos ("turbo" being a generic term for fluid drives of the liquid turbine type in general), as well as to trace the steps in their historical development, it is well to separate turbos into three major classes. These are the fluid flywheel or fluid coupling, the old torque converter, and the wide range turbo which combines the fluid flywheel and the torque converter.

The fluid coupling is the simplest type of turbo, consisting of a fan-shaped impeller, the driving element, which imparts energy to the fluid; and a similarly shaped rotor, the driven element, which receives energy from the fluid. Both elements are contained in a sealed housing which also rotates, usually at engine speed. A system of this type does not increase torque ratios and, therefore, does not replace gears; it merely changes the speed ratio from 0:1 to 1:1. As it is impossible to increase torque above that of the engine, input torque equalling output torque with but a small loss through windage and friction, the fluid coupling functions as an automatic slipping clutch which slips readily at low engine speeds, transmitting very little torque. As the speed of the engine increases, the slipping becomes less and the ability to transmit torque increases until speed and torque ratios of 1:1 are reached.

The efficiency curve of a fluid coupling is that of a slipping clutch, namely, a straight line which rises from 0 to almost 100 per cent efficiency as the ratio of input to output speeds approaches 1:1. This curve cannot be changed by improvements in design; refined hydraulic design, however, can increase the capacity of a coupling. As the horsepower capacity of such a unit increases as the fifth power of the diameter with all dimensions proportional, engineers have usually preferred to merely increase the diameter of the coupling a small amount rather than attempt more complicated designs.

As a fluid coupling does not transmit increased

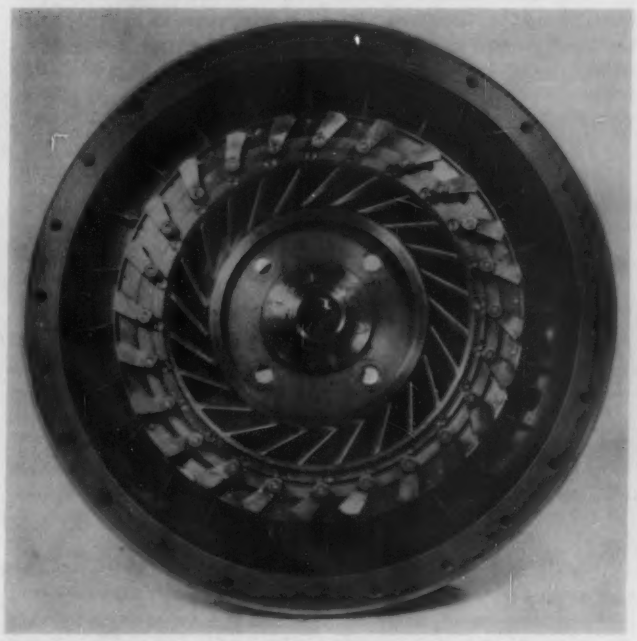


Figure 1. The impeller or driving member of the hydraulic unit

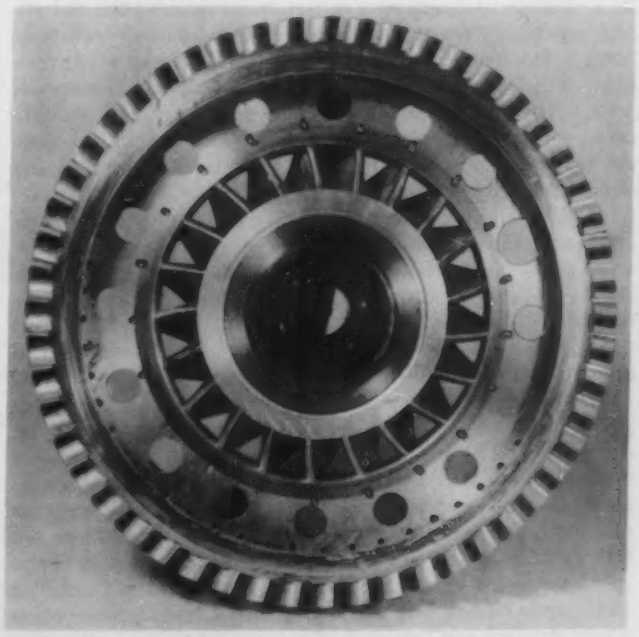


Figure 2. The rotor or driven member of the hydraulic assembly, front-end view

force to the wheels while allowing the engine to turn at a satisfactory speed, a condition required for starting, it is necessary to use some form of gear box in conjunction. Because of the drag torque at idling speeds, a friction clutch is usually employed to facilitate the shifting of these gears. This clutch need not slip to any great degree and, therefore, may be of simple design.

The problem of shifting torque ratios is solved by the second class of turbos, the torque converters. In these a third element called the stator is placed between the impeller and the rotor. Often it is advisable to have two or more stages of rotor vanes. The function of the stator is to absorb the reaction torque and transmit it to the frame. This reaction torque is equal to the torque out minus the torque in when the rotor and impeller are turning in the same direction, and is equal to the sum of torque in and torque out when the rotor and impeller

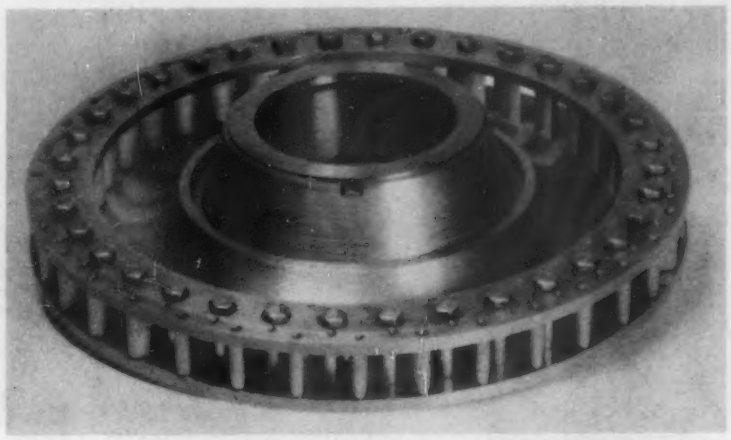


Figure 3. The stator or reaction member of the hydraulic unit

are turning in opposite directions. The quantity of this reaction torque is equal to zero when the input and output torques are equal, but always has a value under every other condition. These simple laws, which in reality are a way of stating Newton's third law, provide a basic principle of the torque converter.

In discussing turbos, one must remember that speed ratios and torque ratios should be considered separately. In a system of gears one is the reciprocal of the other, and hence the two are often considered definitely related. Such is far from the case in fluid transmissions. It has been shown that in turbos of the first class the speed ratio alone was affected; and in turbos of the second class, while the speed ratio varies from 0:1 to 1:1 and the torque ratio varies between wide limits, the two are not necessarily reciprocal.

The efficiency curve of the torque converter is an arc rising fairly straight as the speed of the secondary shaft rises, the speed of the driving shaft remaining constant, until a maximum value of about 85 per cent is reached. As the secondary shaft speed rises and approaches the speed of the drive shaft, however, the efficiency drops rapidly. It is therefore evident that this type of turbo is no longer effective above this optimum point and some other form of connection must be employed. The obvious method is to use a mechanical clutch which will engage by some automatic means as soon as this speed is reached. Although efficiency is retained, the advantages of the flexible fluid drive are lost as soon as the positive connection is made. A turbo of the second class can replace gears and provide an automatic clutch but the benefits of a liquid connection while driving are lost.

An early solution to this major problem was offered by the Tandem Turbo in which both a torque converter and a fluid coupling were placed on the same shaft. The torque converter was used in starting and hill climbing, while the fluid coupling was employed for high speed operation. The fluid was pumped from the one unit to the other at a certain speed, the change being made automatically through a system of valves operated by a governor.

Combined turbos which have been recently developed through the work of Adiel Y. Dodge, Development Engineer of Borg-Warner Corporation, seem to be the most effective solution and the one which is now being widely considered. In these turbos of the third class both torque converter and coupling are combined in one unit. By using a double rotor and an impeller with movable vanes, the position of which change with different speeds, it is possible to vary the shape of the fluid passages and thus automatically convert the design of the turbo from that of type two to type one.

The impeller is shown in Figure 1. The outer ends of the vanes are pivoted and the pivots are counterweighted. The vanes are mounted on the casing of the turbo which turns as a unit and serves as the flywheel of the motor. Figure 2 shows the double rotor assembly which consists of two sets of vanes mounted on a skeleton framework. The stator element is shown in Figure 3. The vanes are mounted on a combined roller bearing and one-way clutch which permits the element to revolve freely in one direction but prevents turning in the other direction.

A drawing of a complete fluid transmission is shown in Figure 4. As this system shows how the combined turbo can be connected with gears to provide effective power transmission under all conditions and illustrates the "two-path power flow," it might be well to discuss it in some detail.

The "two-path power flow" or "series-multiple hook-up" is an ingenious system devised by Mr. Dodge whereby only part of the power passes through the hydraulic unit, the rest going through the central shaft. At the start 50 per cent of the power is applied to the impeller while 50 per cent goes to the gears. Later, as a 1:1 drive is approached, the power through the central shaft decreases and the power through the hydraulic unit increases until, at the 1:1 drive, the hydraulic unit carries about 75 per cent of the load. In this way, the advantages of the turbo are retained, yet at no time is it required to carry the full load. This feature also allows the motor to be cranked by pushing or towing the automobile.

Through a lever which may be placed on the floor, steering column, dashboard, or other convenient position, the gears are shifted to four positions, namely: reverse, neutral, forward, and emergency low. This does not mean that it is still necessary to shift in starting, as all ordinary driving is done in forward gear even when the car is standing still or crawling in traffic. The neutral gear allows the car to be pushed around freely and serves as an intermediate step when shifting into reverse. The emergency low gear is used to climb out of deep ruts or ascend very steep grades.

These hydro-mechanical drives are achieved as follows. (See Figure 4.) In forward drive the sun pinion *A* of the planetary gear assembly is connected to the crankshaft (on the left) by clutch teeth on the central shaft; ring gear *B* is connected to the hub of rotor R_1R_2 by a toothed clutch between planetary unit and hydraulic assembly; and planetary carrier *C* is connected to the tail shaft *E* by the toothed clutch within the cup shaped end of the shaft. In starting there is considerable slippage in the hydraulic unit, so the ring gear turns slowly

while the sun pinion turns at full motor speed. Thus the tail shaft turns slower with increased torque. As the speed increases, slippage decreases until the ring gear and sun pinion turn at substantially the same speed and the drive is practically direct.

In emergency low, ring gear *B* is locked to the housing by the toothed clutch between the planetary unit and the hydraulic assembly and therefore remains stationary; planetary carrier *C* remains connected to tail shaft *E*; and sun pinion *A* is connected to the hub of the hydraulic rotor R_1R_2 by the clutch teeth on the central shaft. Thus the power is transmitted through the hydraulic unit and then through the planetary assembly, which latter, with the sun pinion as the driving member and the planetary carrier as the driven member, gives a reduction ratio of 4:1. In this way the torque is greatly increased both hydraulically and mechanically.

In reverse the sun pinion *A* remains connected to the hydraulic rotor; the planetary carrier *C* is now locked to the housing by the toothed clutch between the hydraulic unit and the planetary assembly; and the ring gear *B* is attached to the tail shaft. With the intermediate gears of the planetary carrier held stationary, it is evident that the ring gear will turn in opposite direction to the sun pinion and the crankshaft in opposite direction to the tail shaft. A reduction ratio of about 3:1 is mechanically obtained.

As it is not necessary to shift gears while in motion, quiet helical or herringbone gears may be used. The gear shift lever merely changes the positions of the toothed clutches as outlined above, and the need of a slipping clutch as now used in most automobiles is eliminated by the hydraulic unit. Although the transmission is almost entirely automatic, speed and torque ratios changing without the driver's intervention, the driver retains complete control over the car as "pick-up" can be acquired by depressing the accelerator more fully and the emergency low and reverse gears are available for unusual conditions.

The Hydra-Matic drive of the 1941 Oldsmobile differs from this system in that a fluid coupling instead of a torque converter is used. As the hydraulic unit of the assembly does not increase torque, it is necessary to employ three planetary units instead of one. By different combinations of the first two, four forward speeds are obtained, and the third unit serves as reverse. The shift from one speed to another is accomplished by locking the sun pinions, planetary carriers, or ring gears of the three units by means of hydraulically operated brakebands. These bands are automatically controlled through hydraulic governors attached to the tail shaft.

The aforegoing discussion serves to illustrate the operation of a turbo of the most modern design. Other turbos differ in many respects, the design usually depending upon the particular installation. It might be well to note the points upon which all turbos (and of all three types) are alike and hence the points which define this form of power transmission. In the first place they are all inherently automatic as far as the type in question goes. Their outside appearance is the same. They are composed of a centrifugal pump (impeller) as the driving member and a turbine (rotor) as the driven member. They all operate on velocity mass flow (or momentum) of the fluid and produce some type of helical torodial flow.

As far as operation is concerned, all fluid turbos form a flexible drive which completely dampens shock. They make it impossible to stall the engine by torque overload. The torque capacity in all types of turbos drops off rapidly as input speed is reduced. They are almost always mounted on the engine crankshaft and replace the conventional flywheel.

The advantages of turbos are many as shown by their rising popularity. In general they furnish a simple, non-wearing automatic clutch which provides smoother starts and allows more effective engine speeds while starting. They deaden torsional vibration, dampen road shock, and eliminate shifting gears almost entirely in the case of the combined turbos.

It seems strange to the average engineer how high efficiencies are possible with turbos while much lower efficiencies are obtained with the best hydraulic turbines. The answer lies in considering the power losses in a turbine. In the first place a great deal of energy is lost in the discharge water of a hydraulic turbine, while in a turbo the liquid is returned to the impeller and the energy is conserved. The second most important loss in a turbine is due to fluid passing over stationary parts such as the fixed casing and the guide vanes. In a turbo,

(*Continued on page 276*)

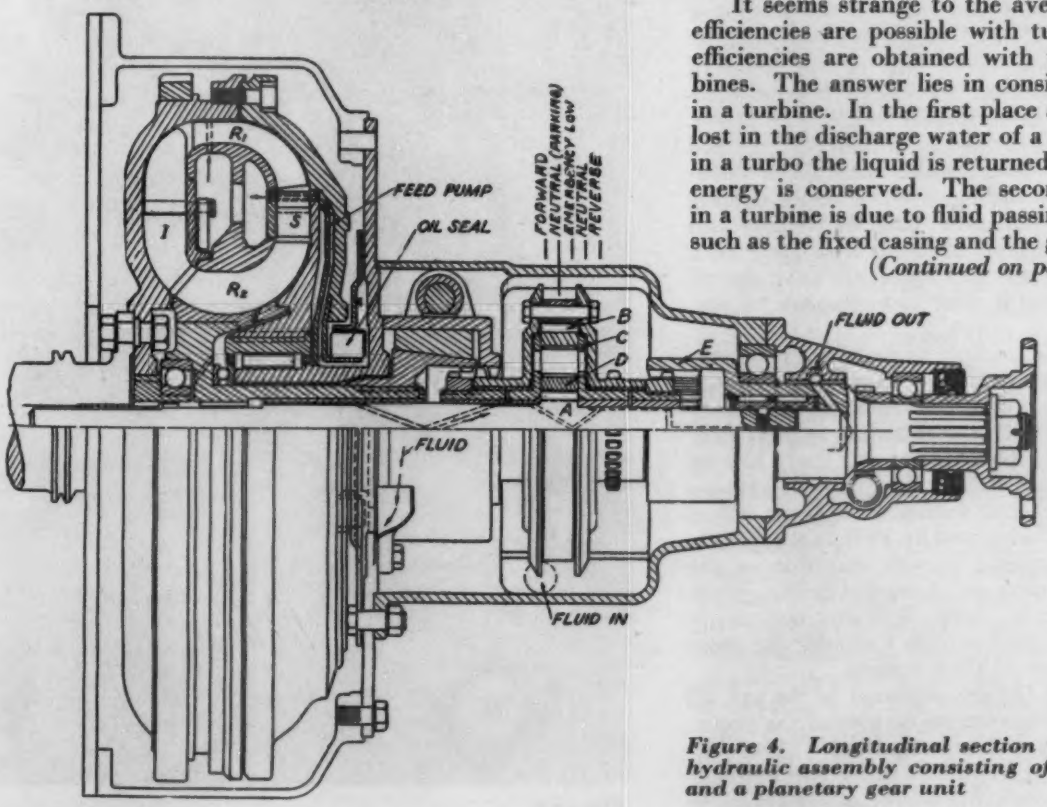


Figure 4. Longitudinal section through a complete hydraulic assembly consisting of a combined turbo and a planetary gear unit

"WAXES" OF YESTERDAY AND TODAY

SINCE ITS CONCEPTION BY EDISON, AN IDEA HAS BECOME THE BASIS OF A LARGE, MODERN INDUSTRY

By A. PULLEY

CHIEF RECORDING ENGINEER, RECORD DIVISION, RCA MANUFACTURING COMPANY, INC.
CAMDEN, NEW JERSEY

THE present day phonograph record and reproducer, when compared to its early counterpart, is a triumph for man and his machines in the age-old quest for a method of preserving the identity of his spoken word so that it might be reproduced at a later time. Although the modern phonograph record dates from about the beginning of the century, history informs us that prior to then there were many schemes developed, some of which permitted the recording only with no method of reproduction, and others that produced fairly acceptable results but were not permanent. Among some of these original recordings that are still available are a number of wax cylinder recordings made by Thomas A. Edison in the latter part of the nineteenth century and now in the possession of the Franklin Museum in Philadelphia. Among these recordings are the voices of King Edward VII, Viscount Gladstone, Charles Dickens and James Whistler. The spoken word of these great men is probably lost because the wax cylinders have deteriorated with time, making it next to impossible to preserve them.

It remained for Emile Berliner to develop the phonograph record as we know it today. It was in the year 1901 that the phonograph emerged from the laboratory into an infant industry with the founding in that year of the Victor Talking Machine Company. Early history of the Company informs us the first year's business amounted to about $500, but within three years it had climbed to a $3,000,000 baby, and by 1905 to a $12,000,000 adult. This phenomenal growth was due to the realization of such artists as Enrico Caruso, Alma Gluck, John McCormack, Evan Williams and many others, who saw in the phonograph a chance for more people to take advantage of their talents.

In the early days of the development of the art, all recording and reproducing systems employed the acoustic method of recording and reproduction. These systems were limited in their frequency range and yet they were developed to a remarkable degree of perfection as

Figure 1

attested to by the recordings made by the great artists of three and four decades ago, which are still very popular today. Among these great artists are such names as Caruso, Schumann-Heink, McCormack, Paderewski, and many others. A look into a recording studio of that era, as shown in Figure 1, shows some of the ingenuity used by the operator and musician in making a record. In the foreground is the large horn for collecting the sound, also an artist playing on a Stroh violin (a special violin with a horn attached) pointing toward the larger horn. It was necessary to group the musicians as close to the horn as possible in order to collect enough sound energy to properly actuate the recording mechanism. In later stages of its development several horns of varied sizes were used to aid in the better pickup of some instruments.

At the advent of broadcasting the popularity of the phonograph record waned for a time. It had reached that stage in its development where radically new methods must be developed before it could be appreciably improved. This required impetus was forthcoming in the development of the electrical method of recording and the Orthophonic reproducer. The electrical method of recording extended the frequency response from approximately 200 to 3,000 cycles, obtainable with the acoustic method, to 50 to 5,000 cycles. It also had the added advantage of "loosening" the artist's movements, permitting a normal "setup" of an orchestra together with his use of a normal instrument, as in the case of the violin. With this method it is now possible to record such great orchestras as the Philadelphia Symphony and the Boston Symphony in their own halls, giving a more lifelike reproduction of the orchestra.

It is worthy of note that at this stage of its development, the record somewhat increased in size and decreased in the speed of recording, and reproduction gave voice to our moving pictures. It did not hold this position long, being quickly replaced by the recording of the sound directly on the film.

Continued development and improvement in electromechanical devices, such as microphones, recorders, pickups, amplifiers, etc., has added impetus to the advancement of the art, until today we have air-conditioned recording studios (see Figure 2) designed to have certain reverberation time characteristics, recording machines with a speed constancy of five parts in a thousand, and a recording system capable of recording the highest fundamental frequency of any instrument in a symphony orchestra.

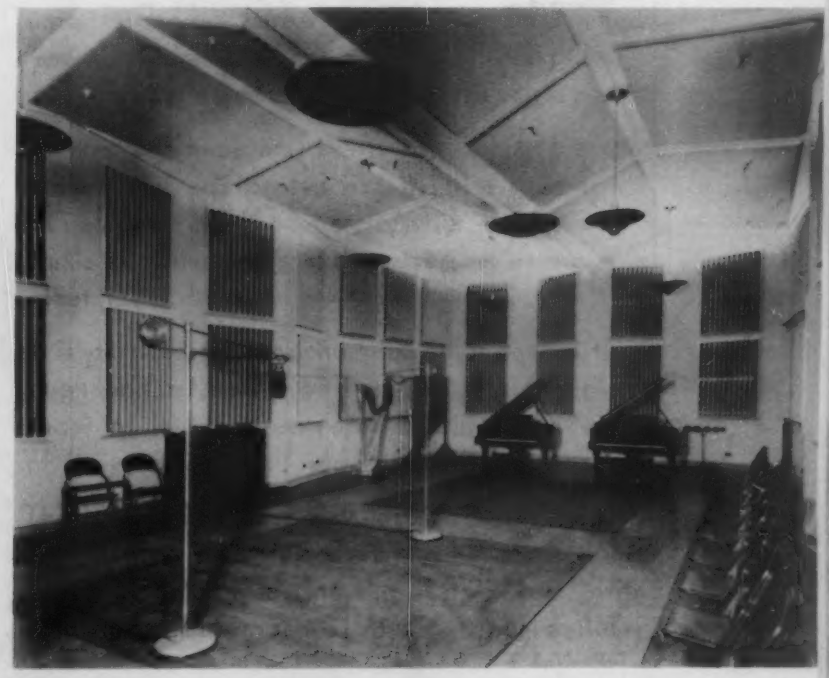


Figure 2

Compare this modern studio and its equipment with its earlier counterpart, as shown in Figure 1. Here we have a place especially designed for the recording of music and so arranged that its acoustic properties can be adjusted to suit the type of music and orchestra being recorded. As we look in the control room of a modern studio (Figure 3) we see an eight position mixer and its associated equipment for the proper control of the volume level of the orchestra and two recording machines for making two duplicate recordings simultaneously.

During this time improvements have not been limited to the recording phase of the art alone. Thomas Edison, in his early experiments, was of the opinion that he could get a better quality of reproduction of the recorded material if he gold-sputtered his wax masters as a first step in the making of a master matrix. He was never able to realize his ambition fully because of the type of material on which the original recordings were made. It remained a problem for modern chemistry to solve; today, thanks to chemistry, we are able to make a recording on a thin film of metallic soap so fine in grain

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structure that we can take full advantage of the benefits of gold-sputtering.

Figure 4 shows the interior of a modern sputter chamber with a plain surfaced wax attached to the door. After the original recording has been made, it is placed in this chamber and the chamber evacuated, and then a very thin film of twenty-four karat gold is sputtered on its surface, permitting the exact reproduction in the master metal matrix of the most minute detail of the record groove.

Plating solutions and methods have also come in for their share of improvements, constant filtration, chemical and temperature control of plating baths having added much to the improvement in signal to surface noise ratio of a record. Further development of the record has reached a point where we must again call upon modern chemistry to improve the plastic in which the finished record is moulded. In this problem it has not been found wanting and we have hopes and expectations that, in the not too distant future, there will emerge from the laboratory a plastic which will give a truly lifelike reproduction of the great artists and orchestras of our time.

Truly, it has been said that man has but to speak and all men may hear, and generations to come will be able to hear as well as read of the great men and artists of our time through the medium of the phonograph record.

Figure 3

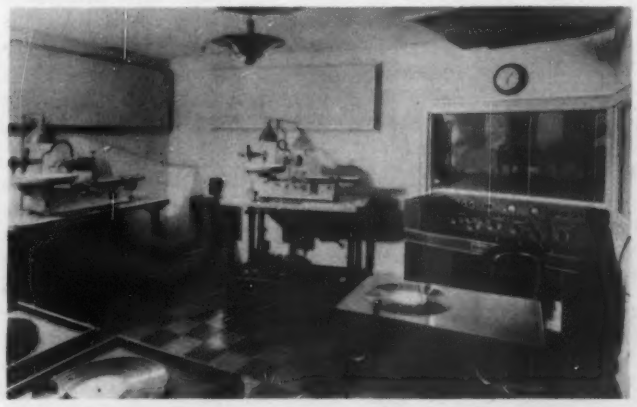
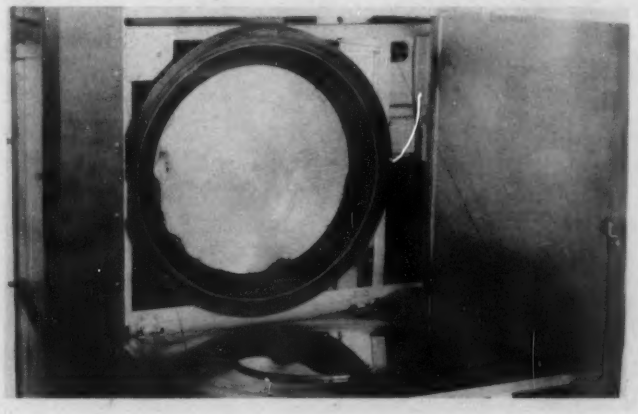
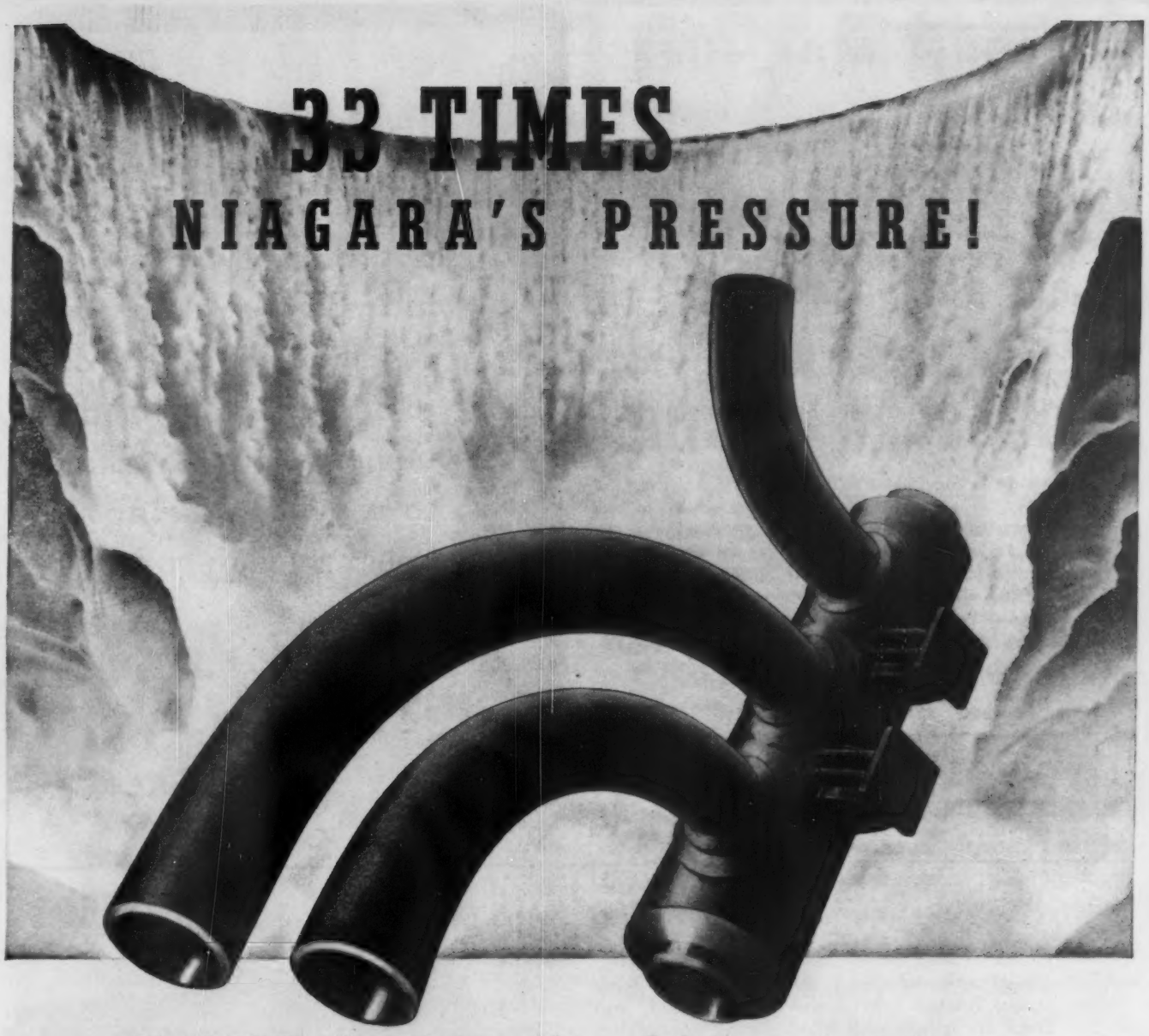


Figure 4





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DETROIT'S CLASS OF '41

(*Continued from page 261*)

adds to the smoothness, silence, and durability of valve rocker arms. Rocker arm shafts are hardened, and rocker arms are granodized after boring to prevent scuffing of the bearing surface.

The electrical system is largely new. A higher voltage ignition coil, new heavy-duty high-compression spark plugs, higher capacity condenser, and battery with non-overflow caps, are some of its features. The breaker side of the distributor cam lobe is made steeper to increase coil output at low speeds and also to speed up operation of the breaker points, thus minimizing the tendency to arc at low speeds.

CHRYSLER

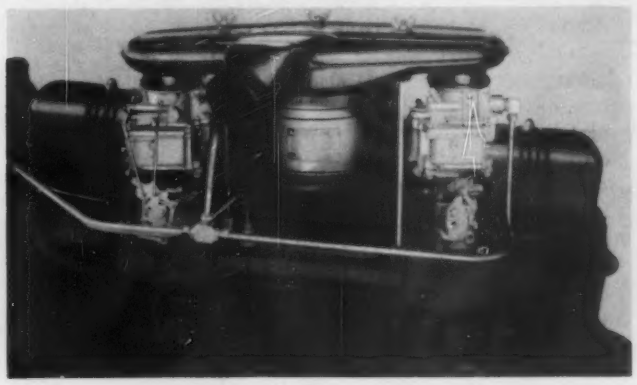
Highlighting an "Airflow" body, the modern outgrowth of the 1934 Chrysler Airflow, four lines of Chryslers for 1941 offer many new advancements.

Fluid Drive, available for the last two years on the higher-priced Chryslers, is now standard equipment on all eights and has been extended to all of the lower-priced cars in the line, on which it is offered as optional equipment at nominal extra cost.

Mechanically the car has been improved by a number of entirely new features. Horsepower has been

(*Continued on page 273*)

Dual carburetion to increase efficiency



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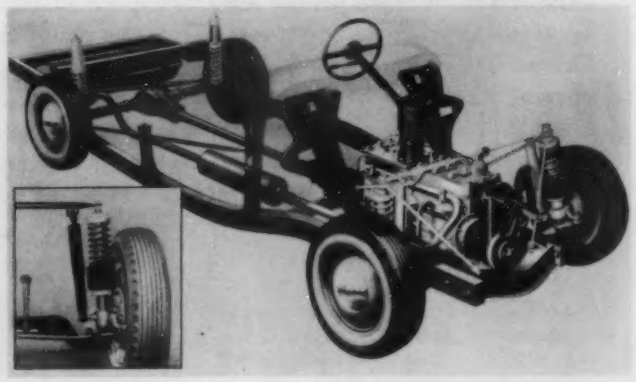

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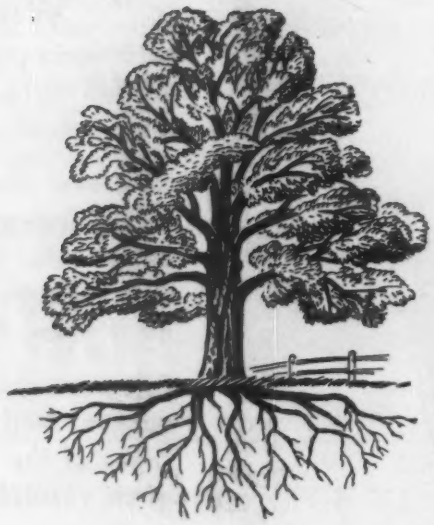
IT'S MIGHTY LIKE A TREE



Though it spreads across the entire nation, the Bell Telephone System is simple in structure. You can think of it as a tree.

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The 24 associated operating companies . . . which provide telephone service in their respective territories.

TRUNK

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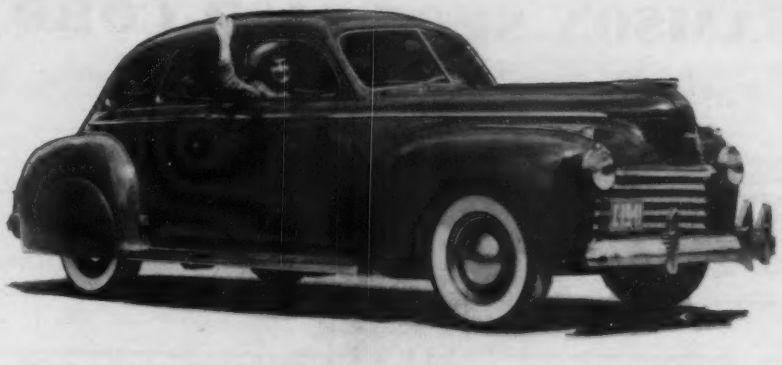
ROOTS

Bell Telephone Laboratories . . . whose functions are scientific research and development; Western Electric . . . manufacturer and distributor for the system; Long Lines Department of A.T.&T. . . . which interconnects the operating companies and handles Long Distance and overseas telephone service.

* * *

With common policies and ideals, these Bell System companies work as one to give you the finest, friendliest telephone service . . . at lowest cost.



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DETROIT'S CLASS OF '41

(*Continued from page 270*)

stepped up by refinements in engine design and by the use of a new type of multiple-jet carburetor, which, it is claimed, will both increase horsepower and promote economy of operation. There are jets for idling and normal driving, and "Spitfire" jets that come into action when the driver "steps on it." A new type of thin babbitt, main and crankshaft bearings is said to increase bearing life up to 500 per cent.

A new "Vacamatic" transmission, used in connection with Fluid Drive, provides automatic safety control.

Other mechanical betterments include oil-bath type air-cleaner as standard equipment; new floating type oil screen on the oil suction pipe; Gerotor oil pumps on all Chrysler cars; transmissions on eight-cylinder cars are equipped with trunnion type shift mechanism which prevents locking in gear and reduces effort to cross over; pedal travel reduced, with over-center spring re-located to reduce friction and minimize pedal effort; clutch-housing ventilation improved by means of new screens and louvers.

The new type of frame is the strongest that has ever been used in a Chrysler car, as well as the most rigid. It is of the double channel type, two U-shaped girders being welded together to form the side rail.

1941 Lincoln Continental six-passenger coupe

1941 Buick Special Sedanet

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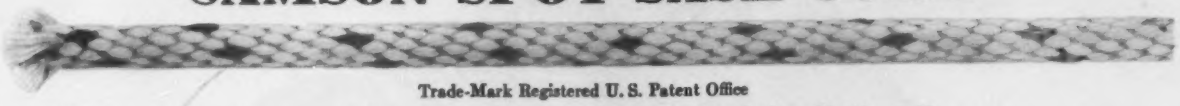

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BUICK

Highlighting a "fireball" engine, compound carburetion, and new styling, Buick presents for 1941 a promising bid to again become America's largest selling medium-priced car.

The new Buick engines have unusually high compression ratios, making them available for the use of the new high-octane fuels now developed for the commercial market. The engines of the "fireball" design have dome-shaped pistons and combustion chamber contours that roll the fuel charge into the shape of a flattened ball directly around the spark plug, providing maximum combustion efficiency without detonation, or "ping."

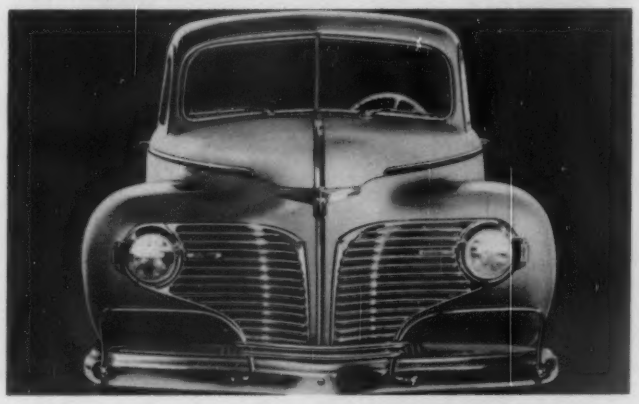
At the same time, compound carburetion, involving the use of two dual carburetors per engine to provide a step-up in horsepower and an increase in operating economy, has been developed by Buick engineers.

One of the more important among Buick's developments on their 1941 models is the steering gear which provides an exceptionally firm, yet "soft" steering action. The steering nut, which rides over the steering worm, is geared to the worm by means of a stream of ball bearings which ride in grooves in the worm and the nut. As the nut moves over the worm, the balls drop out at one end and are returned through tubes to the opposite end, making a closed circuit of ball travel. The ball bearings provide better contact between the worm and nut than is possible in the conventional worm gear steering.

The foregoing paragraphs have given a brief account of the major trends in the automotive field for 1941. That it is a nowhere complete exposition is evident. No mention has been made of the withdrawal of the La Salle from General Motors' higher-priced group, a new low-priced Cadillac being introduced to replace that line. The independent manufacturers have also not been idle, many new features being found on the Nash, Hudson, Studebaker and Packard. Outstanding among these are Nash's invasion of the low-priced field with their Ambassador "600", and Packard's full mechanical refrigeration cooling system.

It is interesting to note that no matter how advanced these cars seem, engineers have already begun drawing plans for the automobile of the future, a machine that will send 1941's contributions to obsolescence.

The Dodge for 1941



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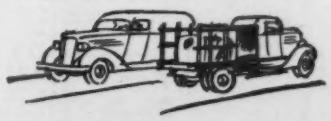
4. Increase accuracy . . . . . .



5. Reduce maintenance . . . . .

6. Resist loads from all directions.

7. Permit high speed operation . .

8. Simplify design . . . . . .

9. Allow accurate inter-changeability.

10. Give assured performance . . .

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BALL BEARINGS

Nothing Rolls Like a Ball

2035

FLUID TRANSMISSION

(*Continued from page 265*)

however, both the casing and the vanes (the stator) are revolving. Another reason for effective performance is due to the fact that the amount of torque necessary to maintain a vehicle moving at low speeds is much less than that necessary at high speed. Thus, although the torque of the turbo drops off at low speeds, the force which is needed drops off at an even greater rate and the required torque is maintained.

The efficiency curves of the three types of turbos discussed in this article are shown in Figure 5. Curve 1 is the straight line characteristic of the fluid flywheel. Curve 2 is the arc of the torque converter which performs efficiently until the optimum point "*O*" is reached and then drops off rapidly. The advantages of the torque converter at low speeds and the fluid flywheel at high speeds are both found in the combined turbo as shown by Curve 3. The curve of a combined turbo with two-path power flow similar to that previously described is shown in Curve 4. Its improvement over the single path arrangement, particularly in the higher efficiency at the point just before direct drive is obtained, can be seen.

As with all new devices disadvantages are quickly noted, although these can often be either disproven or eliminated through perfection in design. The added cost of the turbo, which is now an important factor, is being reduced and, when sufficiently high production rate is established, the turbo will undoubtedly cost no more than the conventional gear transmission. Low efficiency is being remedied as shown above, and turbos whose efficiency is greater than that of a standard clutch and gear box are now being produced. It has been pointed out that starting gears are still used, but this is correct only in the case of the fluid coupling. It is true that the function of overdrive gears cannot be performed by a turbo, but this cannot be classed as a disadvantage as a similar inability remains in the case of the standard transmission.

Prospective buyers often feel that they will have to "learn over" if they obtain an automobile equipped with a hydraulic drive. Such is not the case as the control operations with a turbo as described above are the same as those of a conventional transmission, the only difference being the elimination of shifting while driving. To start, the driver merely shifts into forward and pushes the accelerator; to stop he lets up on the accelerator and pushes the brake.

The uses to which turbos have been placed are many and varied, and undoubtedly numerous other applications will be devised as further refinements are made. In the automotive field Daimler has used a fluid flywheel for several years while the Chrysler for 1939, the Oldsmobile for 1940, and the Dodge and De Soto for 1941 made fluid flywheels optional equipment. Busses in Europe, particularly in London, and Diesel-driven rail cars have made use of fluid flywheels and torque converters. Diesel-driven marine craft are now using various forms of fluid couplings to deaden torsional vibration. Busses in this country have been manufactured with torque converters by Yellow Truck and Coach. Turbos to drive the traction wheels of airplanes which fold their wings and take to the road, have been considered. Turbos have been tried on other vehicles ranging from motorcycles to switching engines.

Although turbos are still in their comparative infancy, the rapid strides which have already been made in their design and application indicate that they will become increasingly important in the transportation industry. The car of the future, driven with only a steering wheel, accelerator, and brake, will in all probability be powered through a turbo.

Graph comparing the efficiency curves of the three types of turbos and showing the effect of the two-path power flow

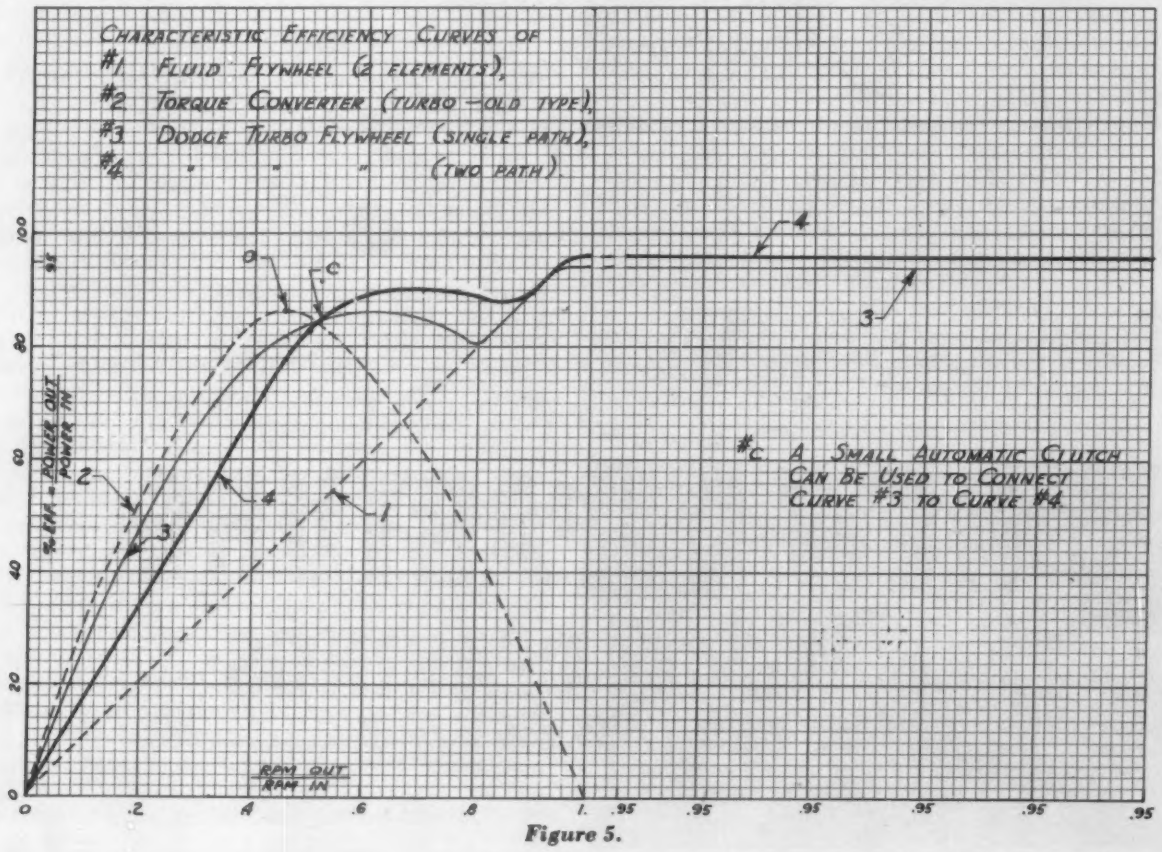

Figure 5.

N. Bonaparte, Strategist

Napoleon liked to take a hill before he took the enemy. From this vantage point he could view the countryside, and call his shots. A little strategy goes a long way.

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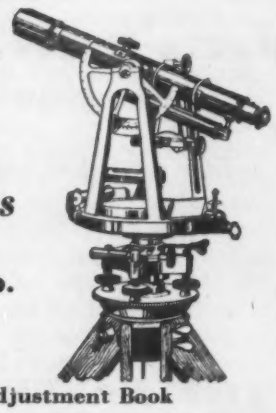
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THE SALES ENGINEER

(*Continued from page 262*)

material can fit a given need is extremely important. The customer is interested in his own problem and the salesman must be able to show him how it can be solved. Beyond that, however, personality plays an extremely important part. The salesman must be of the type who is quickly liked, else he has a tremendous wall to scale. Why we like one person and do not like another is difficult to define. In general we like those who like us, so that the man who is so constituted that he likes most people, in turn will be liked by them. This rules out the pessimist, the non-mixer, the sarcastic, and the tactless. If you cannot see much good in your prospect he will not see much good in you. The salesman must be imaginative, he must be able to counter objections quickly, he must be not too talkative or too silent. Above all, he must have the viewpoint that the things that are are not necessarily the best. An important advantage of the technical salesman is the fact that his chemical knowledge of the product and his engineering knowledge of processes help him to gain an entree beyond the purchasing department. In most companies the real control of what is to be bought is in the hands of the production department since they signify what they want. Therefore, it is very essential to get close to the production men. The average operating man despises the salesman unless the latter can talk his language.

It is in presentation of the case that most chemical engineers are more likely to fall down. In other words, the emphasis here is on form rather than substance. The chemical engineer usually is quite sure of the substance of his talk but the form is likely to be ragged. The chemical engineer intending to go into selling should practice public speaking and should be interested in debating and in report writing. Clinching the case calls for a knowledge of psychology. The chemical engineer has no advantage over the non-technical salesman here, but he must learn to do it as well as the latter. Practice, observation, and contact with successful salesmen will help him to sense when the psychological moment has arrived.

In the chemical industry we have two stages in selling. The sales development section deals with technical complaints, which result in fitting the product to customers' needs. They introduce the results of application research in the form of new uses for their product. When something new is to be put on the market the sales development department decides where it will be tried and by whom, and works out the use in the customer's plant.

When the uses of a product are thoroughly developed it is turned over to the regular selling force which carries it on to all the units of the industry which can utilize it. The sales department should be the eyes and ears of any company. The research development should be pushed by sales into lines that the customer wants, rather than be allowed to develop into those which it is convenient to make due to the production set-up.

We are asked many times what kind of training is best for the chemical engineer going into sales. It is my feeling that college is the time to get technical fundamentals which will probably not be acquired later. Too much broadening into economics and similar business subjects which can be learned outside of school may prevent the acquisition of that training which only the college can give. Obviously, this statement should not be taken as advising against general courses, but only as opposed to too much smattering resulting in lack of the key training. In industry, if it is at all possible, it is advisable for the chemical engineer going into selling to get some production experience. The ability to demonstrate a process in the customer's plant and obvious familiarity with the handling of equipment is bound to be a vital factor in closing a deal. Likewise an understanding of production problems in your own plant eliminates asking the impossible from the production department. Such study in business management as can be carried out in spare time is now particularly desirable.

The hardest thing for the true salesman to learn is to wait until his training is complete. From his very nature the true salesman wants to get out meeting people and actually carrying on his selling work. More than most he fails to realize how important is the development of background, judgment, and knowledge, which can only be acquired through a considerable apprenticeship. It is obvious to any experienced man that the fundamentals of sales must be learned exactly as are the fundamentals of production or research. Even as the production department would not think of putting a young man fresh from school in charge of operating a plant, so too the sales department cannot permit important customer contacts by men of inexperience and without background.

The field of selling is relatively uncrowded with technical men. It affords the possibility of wide contacts and a broad knowledge of many industries. The salesman is usually in closer touch with management and such knowledge tends to promotion. Everyone likes the man who brings in the money, and the myth that the chemist cannot be a business man has been exploded.

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G-E Campus News

SUICIDE LAMPS

DID you ever take up a newspaper and read that someone committed suicide by jumping off a bridge? That's what high-intensity street lamps have been doing, too—not jumping off bridges, but committing "suicide."

Certain smooth-surface street-light reflectors reflect heat back to the lamp filament, thus raising the filament temperature to the point of early "suicide" or burnout.

In an attempt to do something about this, G-E engineers developed the stepped reflector. The inner surface of the reflector is broken up into small steps in such a way that light and heat rays reflected back from the steps just miss the vital lamp stem. Tests showed that, with a 500-watt lamp, the temperature at the lamp stem was 275 F less with the new reflector than with the old one.

The engineers who developed the stepped reflector are graduates of the General Electric Test Course, open to selected graduates of recognized engineering schools.

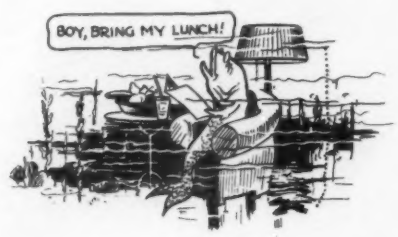
CHASING SHADOWS

HOW would you like to see carbon dioxide pour out of a beaker and snuff out the flame of a candle, or cold water from floating ice flow to the bottom of a glass? By accident two General Electric scientists recently discovered a comparatively simple way to force these and other ordinarily invisible things to show themselves.

It all began one day when a searchlight shining through the windows of the G-E Research Laboratory at Schenectady, N. Y. started the scientists on an investigation, resulting in equipment which gives the inside story of supposedly invisible happenings.

By holding transparent substances in a beam of light from a water-cooled mercury lamp, variations caused by changes in the index of refraction show up plainly on a screen. It's something like seeing heat waves rise from a hot pavement in the summer. Gases, liquids, or transparent solids cast strange shadows, revealing characteristics unseen to the naked eye. Although this has been done before with arc lights, the new method has many advantages.

The two G-E scientists identified with this accomplishment are Dr. R. P. Johnson, U. of Richmond, '29, and Dr. N. T. Gordon, Princeton, '13.



PISCATORIAL UTOPIA

INSECT laboratories have been air conditioned, rivets for dirigibles have been refrigerated so they can be driven better, and there is even a case where telephone books have been cooled mechanically to speed the hardening of the glue. But it was only recently that the first automatic heating installation designed specifically for the comfort and health of tropical fish was put into operation.

Devilfish, sharks, rays, the only porpoises in captivity, and thousands of other unusual specimens caper gaily around in their adopted home in the Marine Studios at Marineland, Fla. There, in huge tanks, the pampered fish live the "life of Reilly" (the porpoises are fed by hand) in water that is not only filtered and aerated but is also held at a temperature of 70 F.

Five General Electric oil furnaces do the heating job, holding the 500,000-gallon "oceanarium" at a temperature just like home for the transplanted tropical specimens.

At G.E.'s Bloomfield (N. J.) plant, where air conditioning equipment is manufactured, is a division of the General Electric Test Course. Here young student engineers gain practical experience in this branch of engineering.

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